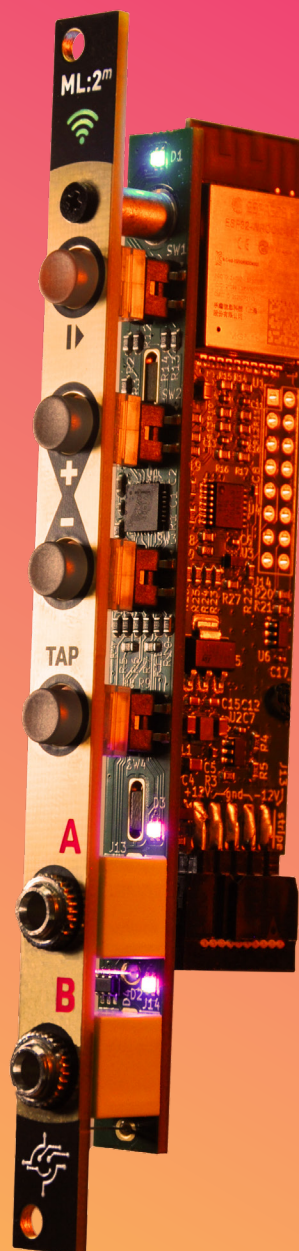


Owner's Manual

Firmware version 1.5

THE MISSING LINK ML:2^m

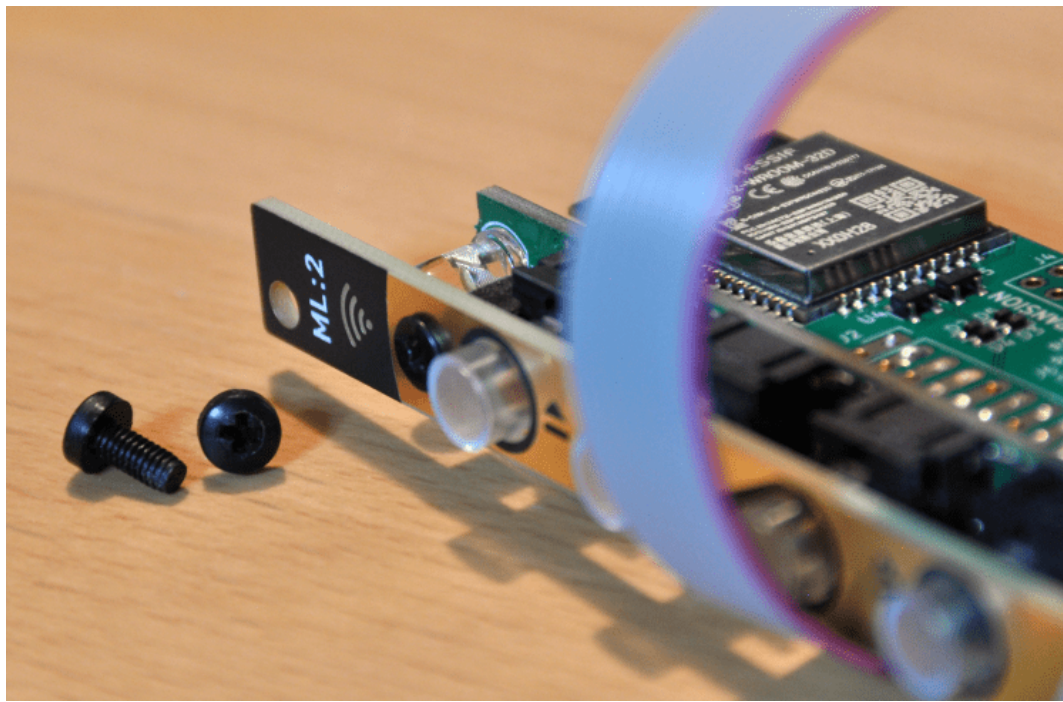
CV and MIDI
Clock Generator



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1 Getting Started



ML:2^m includes a ribbon power cable and nylon M3 screws for connecting to your eurorack system.

1.1 Installing Your Module

1. Power off your eurorack system.
2. Plug in the power supply ribbon cable from the ML:2^m to your system's power. Plug in the power cable so the red stripe aligns to the -12 V marked on the circuit board. If you happen to plug in the power header backwards, do not worry! There is reverse power protection. Just power off your case and re-plug the power cable in the other direction.
3. ML:2^m includes two nylon M3 screws to secure the module to your system's mounting rails.
4. After ML:2^m is correctly plugged in to power and screwed in to your case, power on your system to boot up ML:2^m!

1.2 Connecting To Your ML:2^m

When ML:2^m boots up, it will automatically go in to **Access Point Mode**. The WiFi light will slowly pulse to indicate this mode.

In Access Point Mode, ML:2^m creates its own WiFi network. Connect your computer or mobile device to this WiFi network. The name of the network is included on the back of

the Quick Start card included in the ML:2^m box.

The network name looks something like this: **ML2M-XXXX**

The default password is: **link1234**



The exact name of the network is included in the Quick Start card and is also affixed to the module itself

1.3 Configuring ML:2^m with the Editor

ML:2^m hosts its own web app Editor for configuring its settings. The URL is based on the same name as used in the Access Point WiFi network.

The URL looks something like this: [http://**ml2m-xxxx**.local/](http://ml2m-xxxx.local/) (bold text is the same name used in WiFi network)

After the Editor loads, a message should greet you and guide you through the rest of the setup process.

The WiFi light will glow a solid color when it has successfully connected to your local WiFi network. If it failed to connect, it will go back in to Access Point Mode.

If the **ml2m-xxxx**.local URL does not work

If you are connected to the ML:2^m WiFi Access Point and you are not able to connect to the ".local" web address then your mobile or desktop computer may not support mDNS. This is required to allow the ".local" address to work.

Try entering this IP address instead: **http://192.168.4.1**

1.4 Connect ML:2^m to Your Modules



Output A is generating a clock signal for a sequencer module and Output B is triggering a reset to the Reset input of the sequencer at the start of each loop.

1.4.1 The A and B Outputs

ML:2^m has two TRS outputs, A and B. The outputs can be configured to generate clock, loop reset trigger, or a high gate while the clock is playing. Output B can further be configured to generate MIDI Clock sync.

The factory default settings for the two outputs are as follows:

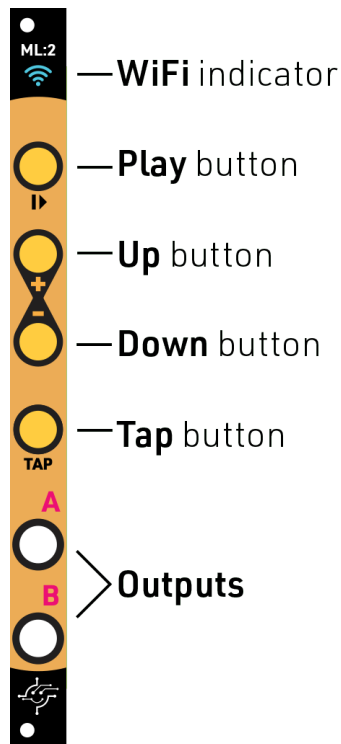
- A: 4 PPQN clock
- B: Loop Reset Trigger

Patch Output A in to the Clock/Sync Input on the module you wish to synchronize with ML:2^m. Patch Output B in to the Reset Input, if your module has one.

When you press the Play button on ML:2^m it will start generating a clock signal on Output A. Output B will create a trigger at the start of each loop. The lights in the four buttons will cycle from top to bottom showing you the phase, or position, of your loop.

You may have to change the settings of Output A and B to match the module you wish to synchronize. [Click here to learn more about the Output Settings.](#)

2 The Front Panel



The front panel of ML:2^m consists of four buttons, two output jacks, and a WiFi status indicator light.

2.1 WiFi Indicator Light

The WiFi indicator light communicates the status of the WiFi connection.

- The **light blinks quickly** to indicate it is attempting to connect to a WiFi network.
- The **light is lit a solid color** to indicate it is connected to a WiFi network.
- The **light is slowly pulsing** to indicate it is in Access Point Mode.

2.2 The Buttons

There are four LED backlit buttons. The primary actions of the buttons from top to bottom are:

1. **Play**: Start or stop the clock output
2. **Up (+)**: Increase tempo by 1 BPM. Hold the button down to increase the tempo continuously.
3. **Down (-)**: Decrease tempo by 1 BPM. Hold the button down to decrease the tempo continuously.

4. **Tap**: Press the button 2 or more times to set the tempo to the rate at which you pressed the Tap button. The Tap button also is a modifier button used for some special actions described below.

2.2.1 Loop Phase Meter

The buttons animate in a downward loop to visualize the “loop phase” of your ML:2^m within the Ableton Link timeline or grid. If there are no other Link peers on the network the ML:2^m will not animate the button LEDs until the clock is Playing.

2.2.2 Tap Button as a Shift Button

Holding the Tap button and then pressing the Play, Up, or Down buttons will invoke a secondary function for those buttons.

- **Tap & Play**: This function is user-assignable with two available options:
- **Reset On Next Loop**: (Factory Default) The MIDI port will send a Start Transport message at the start of the next loop. Output A or B, if set to Trigger Reset will send a reset at the start of the next loop, even if it is set to only send a reset on start or stop.
- **Reset The Timeline Now**: Reset the Link timeline grid to the moment you pressed the Play button. The timeline will re-align to “now”, Output A and B will send resets if they are set to Trigger Reset, and the MIDI port will send a Start Transport message. This allows you to re-align the Link grid if you are performing with musicians that are not on the Link grid and you wish to re-align to their downbeat.
- **Tap & Up** button: Increase PPQN to the next option in the PPQN list. The Up and Down buttons will blink quickly to indicate you have reached the upper limit of PPQN options.
- **Tap & Down** button: Decrease the PPQN to the previous PPQN option in the PPQN list. The Up and Down buttons will blink quickly to indicate you have reached the lower limit of PPQN options.

2.2.3 Secondary Menu

Holding the Tap button for three seconds will change the Play, Up, and Down buttons' actions and the button's lights will display a secondary menu. The Tap button will blink to indicate you are in the secondary menu. The Up and Down buttons adjust the amount of Shuffle applied to the clock. If the Up or Down button is lit dimly, that means you are at the minimum or maximum value. The Play button will illuminate based on the Output B MIDI Mode setting.

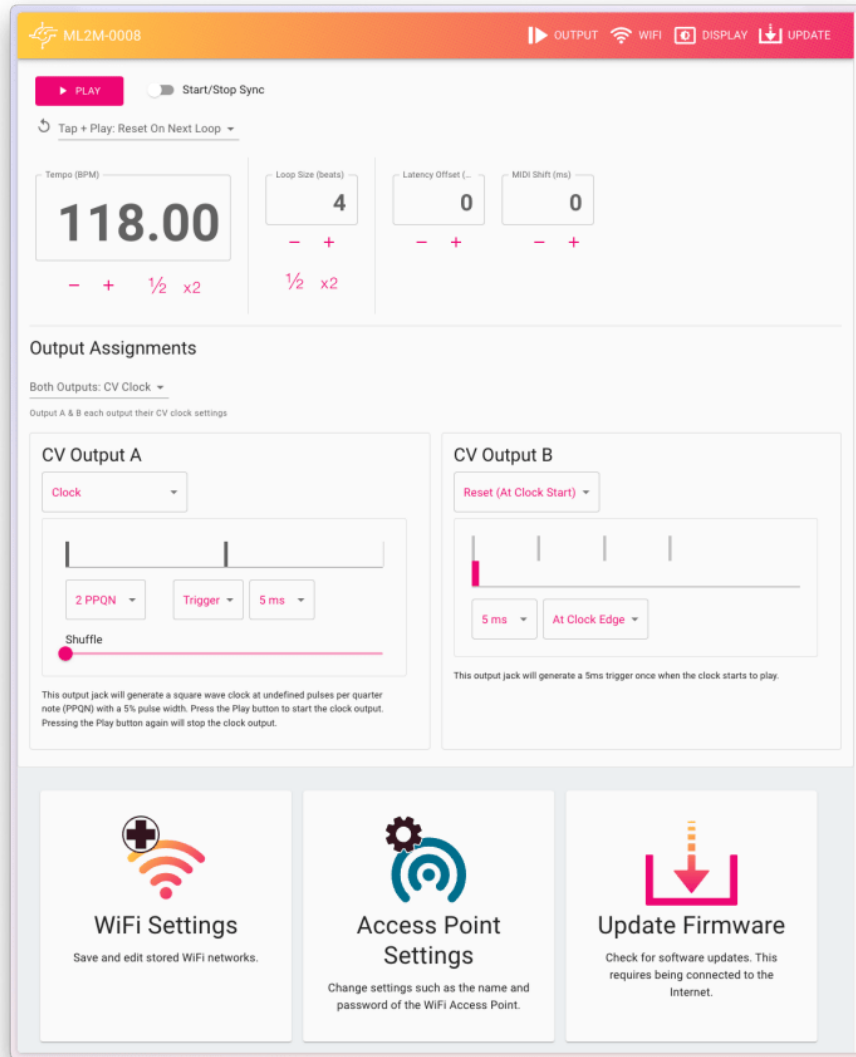
- **Play**: Toggle Output B MIDI Mode. The Play button will be illuminated to indicate MIDI Mode is enabled and not illuminated if MIDI Mode is disabled.
- **Up**: Increase Shuffle. The Up button will be lit dimly when you hit the upper limit of the shuffle parameter.

- **Down:** Decrease Shuffle. The Down button will be dimly lit to indicate you have hit the lower limit of the shuffle parameter.
- Press the **Tap** button again to exit this mode.

2.3 The Outputs

The two outputs, A and B, are 5 volt digital outputs that are configurable in a number of ways. See [Output Settings](#) below for more details.

3 The Editor



The Editor Home Page

Since the interface of ML:2^m is so minimal, there are many settings that can not be easily accessible via the front panel. The ML:2^m instead hosts a web-based interface to access these settings called the Editor. In the Editor you will find settings for storing and editing WiFi networks, performing firmware updates, and changing the playback behavior of the A and B outputs.

3.1 Connecting to the Editor

If ML:2^m is in Access Point Mode, then connect your computer or mobile device to the ML:2^m WiFi access point. The default name of the network is the serial number attached to your ML:2^m circuit board. The serial number also included in the Quick Start card included in the box with your ML:2.

If your ML:2^m is connected to your local WiFi network then connect your computer or mobile device to the same local WiFi network.

3.1.1 Connecting via the ".local" URL

Now that your computer or mobile device is on the same network as your ML:2^m, you can access the Editor by opening a web browser and entering the following URL based on your Missing Link serial number:

<http://ml2m-xxxx.local/>

The exact name is included next to your serial number on the quick start card or on ML:2^m circuit board. Also note that there's a trailing "/" at the end of the URL. Some browsers need this forward slash in order to correctly parse the URL.

3.1.2 Connecting via an IP address

If your Windows computer or mobile device does not support Multicast DNS (aka Apple Bonjour) you will not be able to access ML:2^m via its ".local" web address. Apple has a [Windows installer for mDNS/Bonjour support](#). If you cannot install mDNS services then you will have to access your Missing Link via its IP Address.

ML:2^m IP address when in Access Point Mode

The IP address to access your ML:2^m Editor is:

<http://192.168.4.1>

ML:2^m IP address when connected to your own WiFi network

The IP address is not known when it is connected to your own WiFi network since the address will be dynamically assigned by your WiFi router. If you need to connect via IP address then you should configure your WiFi router to give your ML:2^m a dedicated IP address. You can do this with most routers via the router's administration app or web page.

3.2 The Menu Bar



Desktop web browser view of the menu bar.



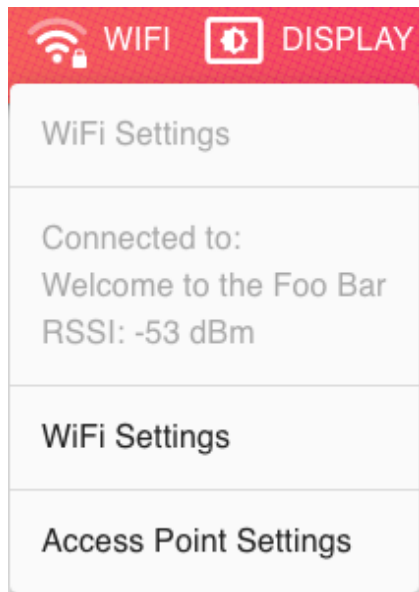
Mobile view of the menu bar is revealed when clicking the three-line “hamburger” menu.

There are several buttons across the top of the web interface for accessing various settings areas. If you access the Editor from a device with a smaller screen, such as your phone, these menu items are accessed via a menu button on the upper left of the screen.

3.2.1 Output

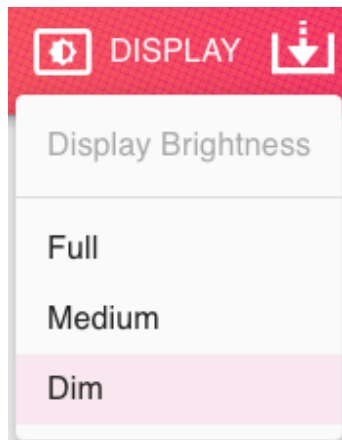
Click the Output button to bring you to the “home” page where the Output Settings live.

3.2.2 WIFI



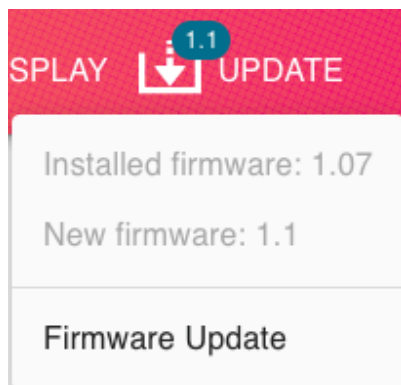
Click the WiFi button to open the WiFi menu. In the WiFi menu you will see information about your WiFi connection as well as a links to the [WiFi Settings](#) and [Access Point Settings](#) pages.

3.2.3 Display



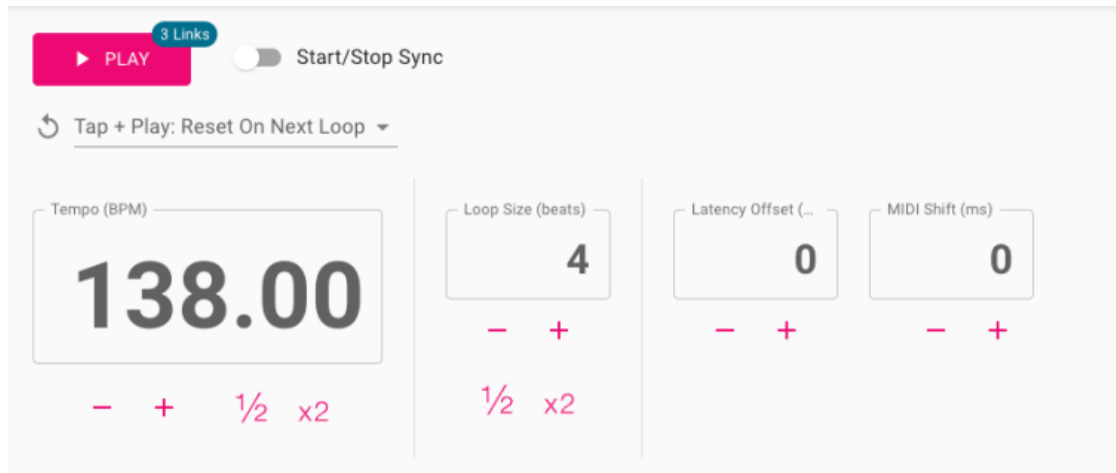
Click the Display button to show the display brightness setting. This will dim the buttons, WiFi indicator, and the A & B output indicators.

3.2.4 Update



Click the Update button to see the currently installed firmware version as well as a link to the [Firmware Update](#) page. If there is an available update a flag will appear next to the Update icon indicating the new firmware version number.

4 Playback Settings



4.1 Playback Settings

At the top of the main Editor page, just below the menu bar, are the Playback Settings. This includes a Play/Stop button, Start/Stop Sync switch, Tempo, Loop Size, and Offset controls.

4.1.1 Start/Stop Sync

When this feature is enabled The Missing Link will listen for Start/Stop transport messages from any other Link 3.0 peers with Sync Start/Stop enabled. If any of the devices start playing or stop playing the other devices will also start or stop playing.

This is an Ableton Link 3.0 feature. Your other Link apps or devices may not support Link 3.0 and thus, may not work with this feature.

4.1.2 Tempo (BPM)

The tempo controls how fast everything plays. Tempo is set in Beats Per Minute. Changing this value will also change the Tempo of any other Link devices you are networked with.

You may either enter a new tempo via the text input box or use the + or – buttons to increase or decrease the tempo. There are also **1/2** and **x2** buttons to double or half the tempo.

4.1.3 Loop Size (beats)

This feature sets how often a Loop Reset output triggers. It also controls quantization of the Play/Stop control. The value of Loop Size is in beats (quarter notes). Setting Loop Size to a value of "4" will cause a Loop Reset Trigger to happen every bar in a 4/4 time signature.

You may either enter a new Loop Size via the text input box or use the + or – buttons

to increase or decrease the Loop Size, one beat at a time. There are also **1/2** and **x2** buttons to double or half the Loop Size.

4.1.4 Delay Compensation (ms)

When using the Rhythm Explorer CV clock mode this loop size also sets the loop size of that CV clock's output.

Devices on an Ableton Link peer network can be time-shifted ahead or behind other Link peers. Sometimes the device you are synchronizing might have its own built-in latency that causes it to play a little bit behind the Link grid. In either case, you can use this setting to shift your clock output in time to better align with the Link music grid. Enter a value in the text input box or use the **+** or **-** buttons to increase or decrease the Delay Compensation. This value is in Milliseconds.

4.1.5 MIDI Nudge (ms)

MIDI devices have their own internal latency when responding to MIDI messages. A little delay here will nudge your MIDI devices in to alignment with the devices being sync'd via Output A or B. This setting has a range of -10 to +100 ms.

5 Output Settings

5.1 Output Assignments

Output Assignments

Both Outputs: CV Clock ▾

Output A & B each output their CV clock settings

The TRS output jacks can be configured in one of two ways:

- **Both Outputs: CV Clock.** The Output A and B generate CV clock signals based on the CV Output Settings.
- **Output B: MIDI Mode.** Output B sends MIDI clock messages using the TRS A MIDI hardware spec. The “B” indicator on the faceplate will glow a solid orange color while in MIDI Mode. There is an included TRS to MIDI DIN cable in the box. Output A has the CV Clock A and B signals on its Tip and Ring elements of the jack. You can use the provided TRS to mono splitter cable to access both signals for patching.

5.2 CV Clock Settings

Output Assignments

Both Outputs: CV Clock ▾

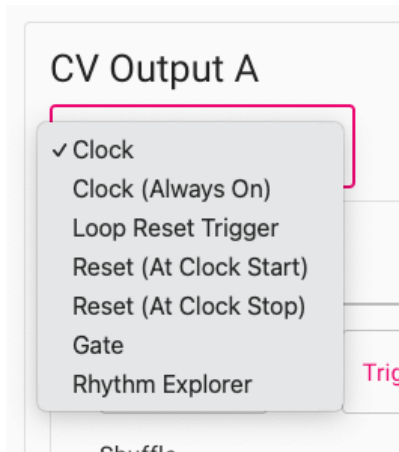
Output A & B each output their CV clock settings

5.2.1 CV Clock Output Settings

The Missing Link has two CV clock outputs: A and B. These outputs can be configured independently. By default, the A output will play a 4 PPQN clock trigger whenever the clock is playing. When the clock is stopped, Output A will output nothing. Output B will output a single trigger at the start of each loop when the clock is playing. When the clock is stopped, Output B will do nothing.

As noted above, Output B can also be switched in to MIDI Mode where it will not output CV clock, but will output MIDI clock sync messages instead.

5.2.2 CV Clock Output Modes



Clock

The chosen output will generate a clock signal whenever The Missing Link is playing. When it is stopped, the output will not create a signal.

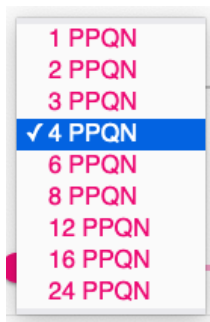
Clock (Always On)

The output will always output a clock signal, no matter the playback status. This mode is useful for any devices that require a DIN Sync style clock. It is usually paired with a second output in Gate mode.

Common Clock Settings

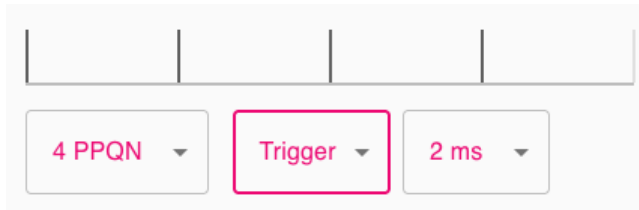
Whether you have chosen "Clock" or "Clock (Always On)" there are several options to set up the clock to your sequencer's requirements.

PPQN



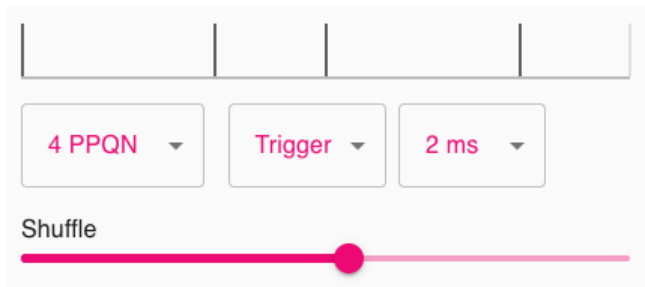
PPQN, or Pulses Per Quarter Note, indicates how many clock pulses to create per quarter note of time. Refer to the manual for the device you are syncing with The Missing Link to find out what PPQN value that device is expecting.

Trigger



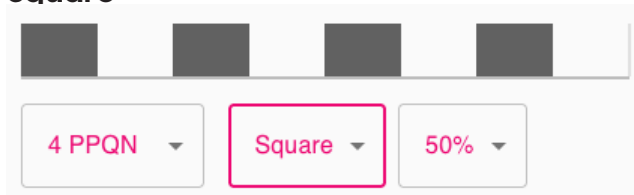
Clock signal will consist of equal length triggers which can be 2, 5, or 10 milliseconds long.

Shuffle



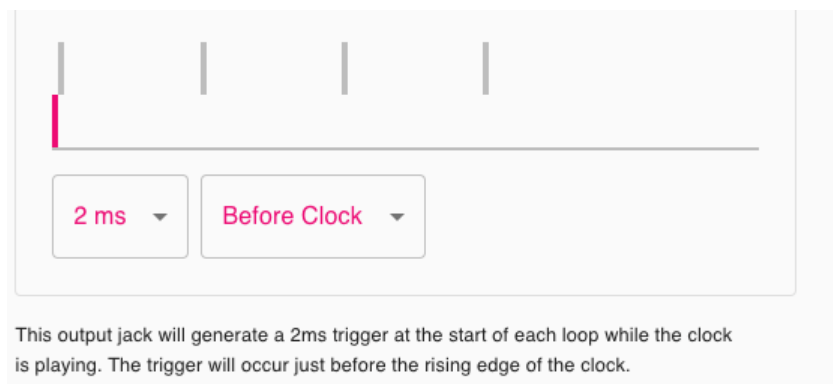
Increasing shuffle will cause the clock triggers to cluster together to add some funky groove to your sequencer. The clock visualization will give you a preview of the shuffled clock triggers. Shuffle is disabled at 24 PPQN. It is also disabled in Square wave clock mode.

Square



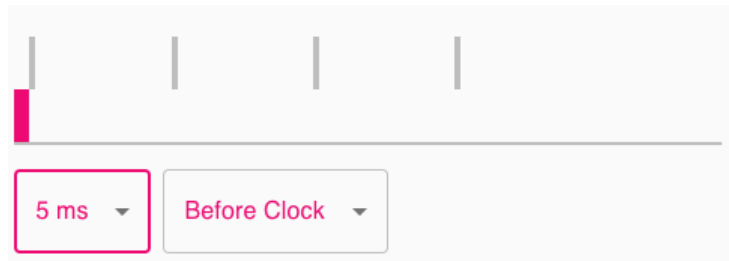
Clock signal will be a square wave signal with a 10, 25, 50, or 75% pulse width.

Reset Trigger / Reset (At Clock Start) / Reset (At Clock Stop)



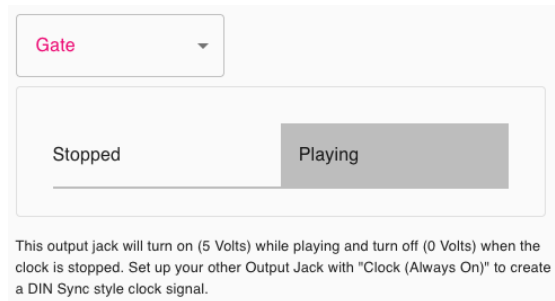
Reset Trigger will generate a trigger at the start of each loop while the clock is Playing. **Reset (At Clock Start)** only generates a trigger at the start of the first loop when the clock starts playing. **Reset (At Clock Stop)** only generates a trigger at the end of the final loop when the clock is stopped. Reset Triggers do not output when the clock is Stopped. The trigger can be set to a length of 2, 5, or 10 milliseconds.

Alignment to Clock Edge



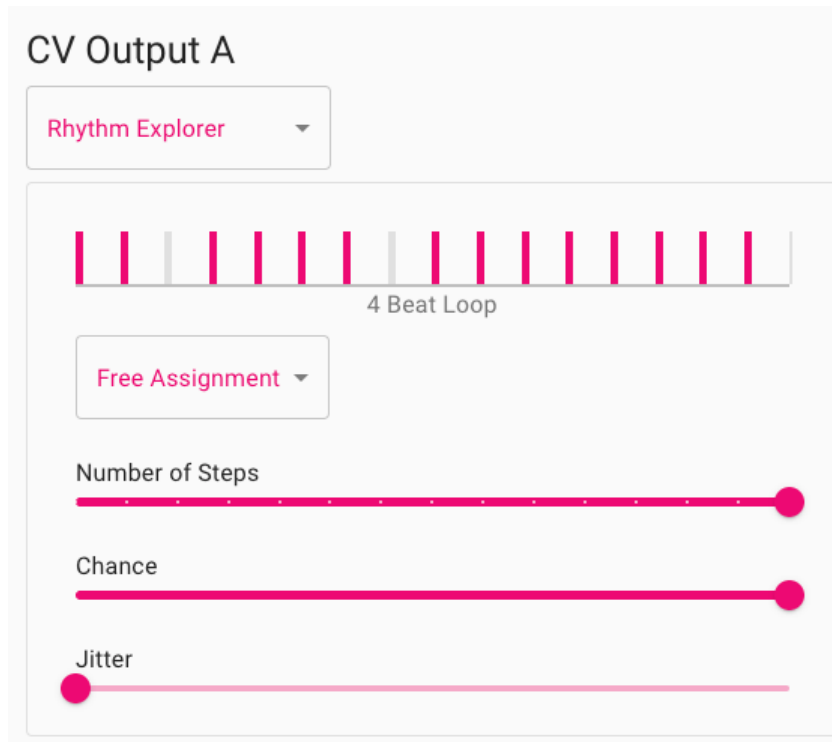
The Reset Trigger can either output in alignment with the clock edge or just before the clock edge of the first clock of a loop.

Gate



The output will turn on (i.e. go high) when The Missing Link is playing. When The Missing Link is stopped, the output will turn off (i.e. go low). This acts as a switch to turn on, or gate, another device whenever The Missing Link is playing. It can be paired with another output set to **Clock (Always Running)** to create DIN Sync-style clocking.

New! Rhythm Explorer

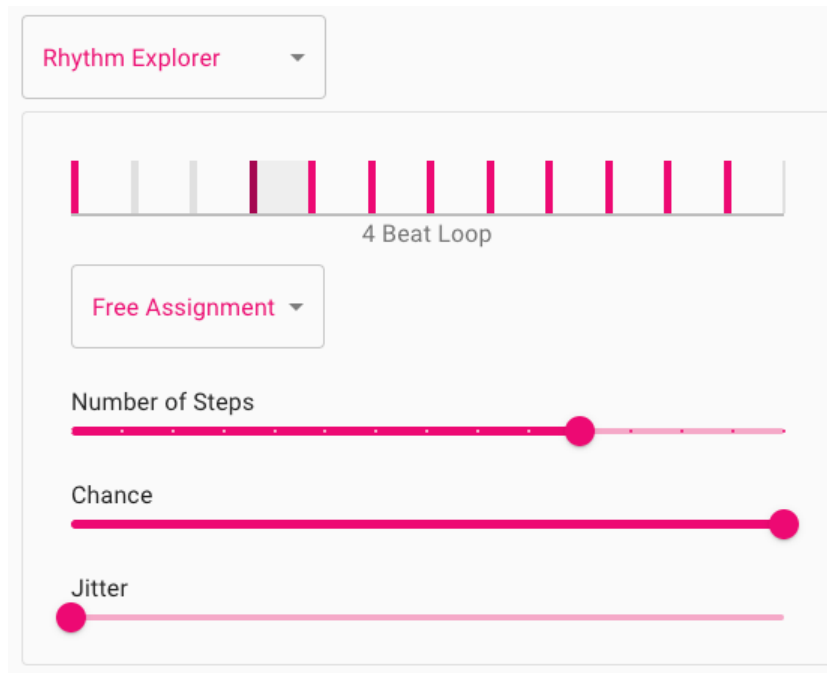


Rhythm explorer mode allows you to disrupt your clocks with some maths and chaos, providing new rhythms into your music instantly. Instead of a regular steady clock, turn on Rhythm Explorer mode to introduce looping patterns as your clock with the ability to choose the number of Steps, Pulses and introduce Chance and Jitter! Rhythm Explorer was inspired by conversations I had with [MATTHS](#). Matt was impressed with the stable clock and Ableton Link integration of ML:2 but wished to “break” the clock in creative ways so his sequencers wouldn’t clock in regular patterns and thus generate all kinds of happy accidents along the way. We hope you enjoy Rhythm Explorer!

A Note About Loop Size

Rhythm Explorer works a bit differently than the other clock modes. The clock pulses in Rhythm Explorer are spread across the Loop Size set in the Playback Settings above. So if you set Rhythm Explorer to 16 steps and Loop Size is set to 4 beats, then there will be 16 steps distributed across those 4 beats (4 clock pulses per beat). If you then changed the Loop Size to 2 beats, the clock output would be spread across 2 beats, similar to clock multiplying by 2 (8 clock pulses per beat). If you changed the Loop Size to 16 beats, then there would be 1 clock pulse per beat.

Rhythm Mode: Free Assignment



Click on a step in the graph to enable or disable it. Disabled steps are a light gray color.

Number of Steps

The number of clock pulses spread across the Loop Size set in Playback Settings.

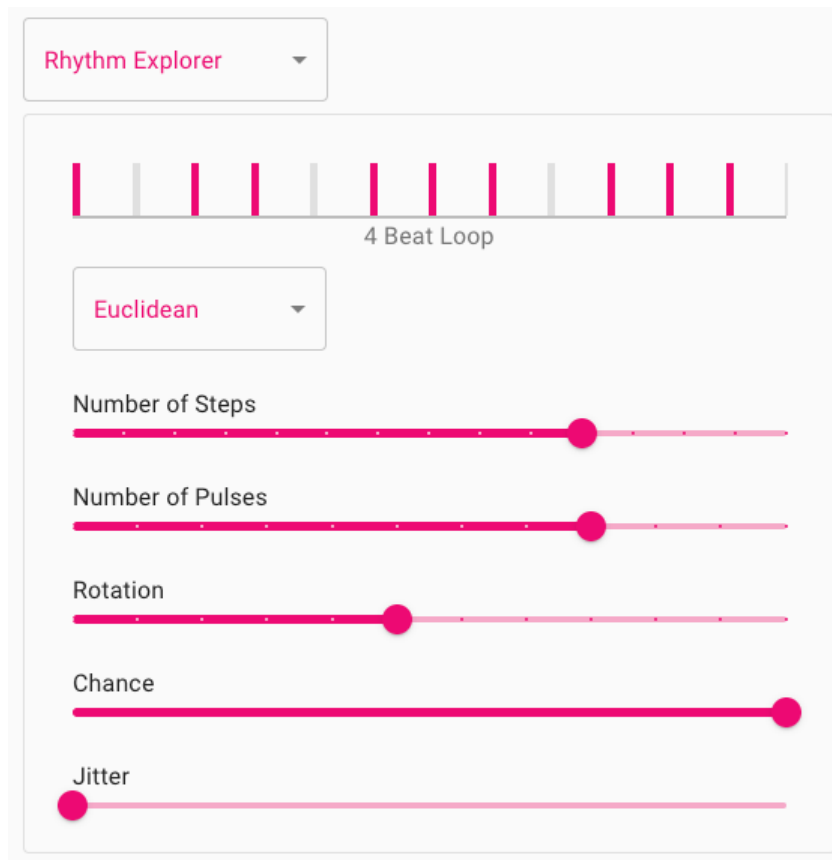
Chance

The percent chance that an enabled clock pulse will output. When this is set to 100% any enabled clock pulse will always output. Set to a lower amount and each time an enabled step is set to output virtual dice are thrown to see if that step will indeed output. Disabled steps are always disabled.

Jitter

Add random variation to the clock pulse output. Instead of outputting accurately, the clock pulses will fluctuate to arrive early or late causing the clocked device to slowdown and speed up over time. Lower settings have subtle effects similar to a shuffled beat and higher settings are chaotic.

Rhythm Mode: Euclidean



Define which clock pulses are enabled and disabled based on Euclidean Rhythm math.

Number of Steps

The number of potential clock pulses spread across the Loop Size set in Playback Settings.

Number of Pulses

The number of clock pulses to enable distributed across the Number of Steps. The algorithm will try to distribute those pulses as evenly as possible across the Number of Steps.

Rotation

Push the clock pulse pattern starting point across the Number of Steps. The clock pulse pattern wraps around to the beginning of the loop if it falls off the end of the loop.

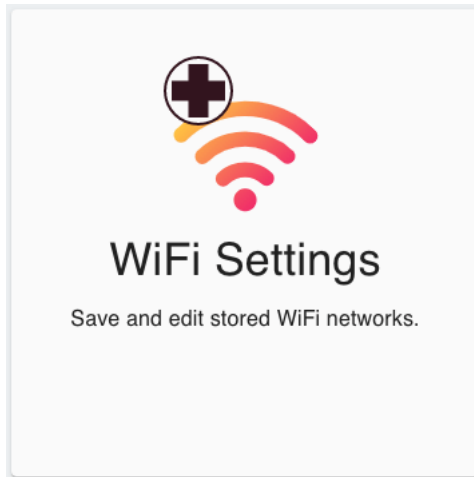
Chance

The percent chance that an enabled clock pulse will output. When this is set to 100% any enabled clock pulse will always output. Set to a lower amount and each time an enabled step is set to output virtual dice are thrown to see if that step will indeed output. Disabled steps are always disabled.

Jitter

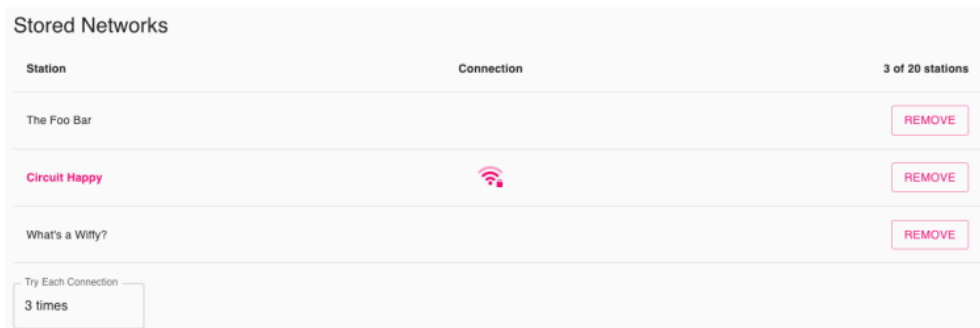
Add random variation to the clock pulse output. Instead of outputting accurately, the clock pulses will fluctuate to arrive early or late causing the clocked device to slowdown and speed up over time. Lower settings have subtle effects similar to a shuffled beat and higher settings are chaotic.

6 WiFi Settings



WiFi Settings is where you store and edit stored WiFi networks. At the top is a list of stored WiFi networks.

6.2.1 Stored Networks



The network in which you are connected will be in bolded pink text. Click the Remove button to remove a stored WiFi network. A dialog will appear confirming the removal of the network. After clicking Yes, another dialog will ask you if you wish to refresh your system. This will reboot your Missing Link.

The small box labeled "Try Each Connection" indicates the number of connection attempts The Missing Link will make before moving on to the next stored WiFi network.

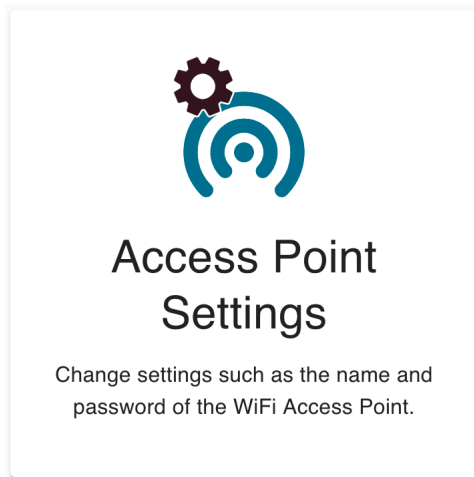
6.2.2 Add New Network



This section displays a list of currently available WiFi networks that your Missing Link has found. Click on a network and a dialog will ask you to enter a password. If your network is an open network (no password needed) leave the password field blank.

If the network you wish to connect to is a hidden network click the "Manually Add Network" button to enter both the name of the network (SSID) and the password to the network.

7 Access Point Settings



Your Missing Link has the ability to both connect to other existing WiFi networks or create its own network. When The Missing Link is making its own WiFi network it is in Access Point Mode. Any other Link devices can join this network to synchronize with The Missing Link. The Access Point Settings page allows you to adjust the Access Point to your liking.

Access Point Settings

When to Create Access Point

When I cannot find a network

Name (SSID)
MLJR-1234 Hidden SSID

Password
link1234 Require Password

SAVE SETTINGS & RESTART

What Do These Settings Do?

When To Create An Access Point:
This Missing Link will attempt to connect to a local WiFi network upon booting up. If it cannot connect to a local WiFi network it will start Access Point Mode.

Name (SSID)
In Access Point Mode, Missing Link will create a WiFi network named:
MLJR-1234
This name is also used to make the local web address for accessing the Web Control Panel. The URL for this Web Control Panel is:
http://mljr-1234.local/
Add a bookmark to this URL so you do not forget!

SSID is Not Hidden
It will be listed when someone scans for available WiFi networks.

Password Is Required
When in Access Point Mode, this WiFi network requires this password to connect: link1234

When to Create Access Point

When to Create Access Point

When I cannot find a network

When I cannot find a network

Always create an Access Point

When I Cannot Find A Network

Your Missing Link will attempt to connect to any of the WiFi networks you have stored in its memory. If The Missing Link cannot connect to one of these WiFi networks then it will start its own WiFi access point, using the settings described below. You can then connect to The Missing Link's WiFi network in order to communicate over Ableton Link or to connect to the Editor.

Always Create An Access Point

Your Missing Link will not attempt to connect to any of your stored WiFi networks. It will immediately create its own WiFi access point, using the settings described below.

Name (SSID)

This is the name of the WiFi network The Missing Link will create when in Access Point Mode. The name is also used in the web address of your Editor. If you change the Name to "MyLink" then the web address to access the Editor would be <http://mylink.local/>

Hidden SSID

Enabling this will stop your Missing Link's WiFi network name from being listed in the WiFi menu of computers or mobile devices. This allows your WiFi network to be a little less discoverable in a situation such as live performance. You do not want people trying to connect to your Missing Link's WiFi network whilst you are performing!

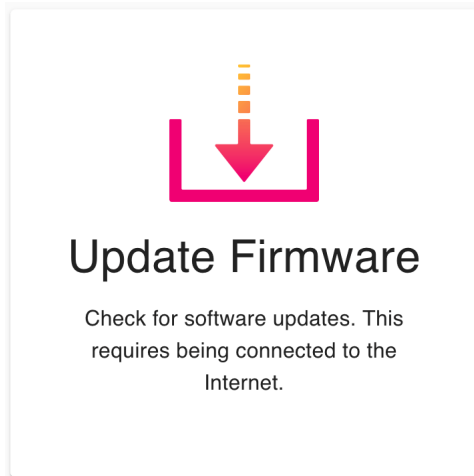
Password

This is the password needed to gain access to your Missing Link's WiFi network.

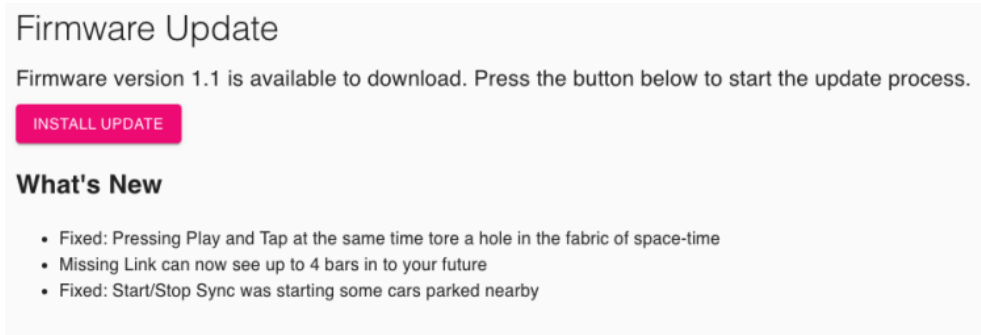
Require Password

Disable this if you wish to have an open network that anyone can easily join. This is nice for Link jams where you want to make it easy for others to join in the fun.

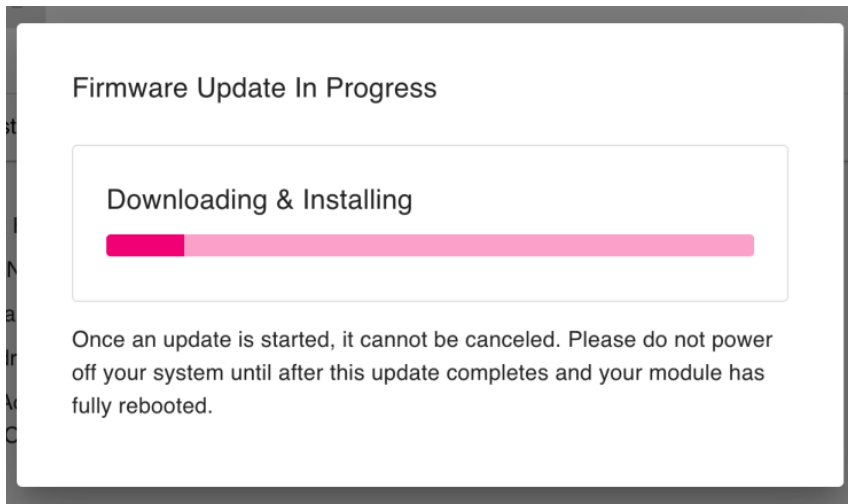
8 Updating Firmware



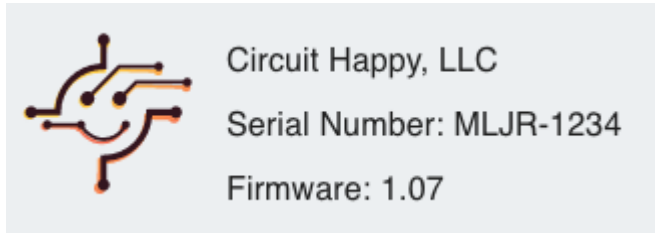
Upon entering the Update Firmware page, The Missing Link will automatically ping the Circuit Happy server to check for an available update. If one is available, a button will appear that reads INSTALL UPDATE. Click it to start the update download and install process.



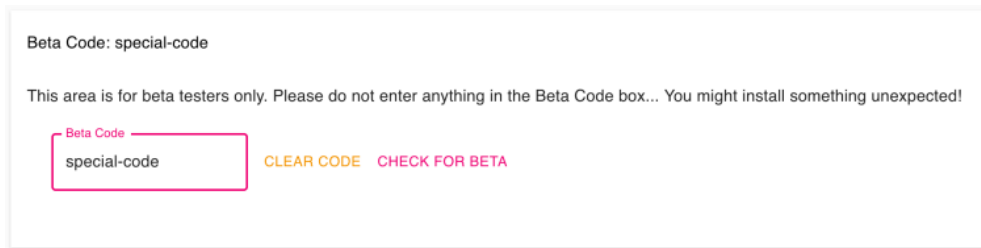
A window will pop up showing the installation progress.



After the install successfully finishes, The Missing Link will automatically refresh the system and the Editor will reload when The Missing Link is back online. You can verify that the new firmware version installed successfully by checking the firmware version listed at the bottom of every page of the Editor:



Beta Codes



At the bottom of the Firmware Update page, there is a "Beta Code" area. If you are a beta tester you would enter a secret beta code here to install a beta firmware. Unless you are participating in a beta testing program, please leave the Beta Code box empty.

9 I can't connect to the Editor

Networking can be very tricky. Here are some suggestions if you are having problems connecting to your ML:2^m Editor.

Make sure that your computer is connected to the exact same WiFi network as your ML:2^m. If your computer is connected to the WiFi network with "My Network 5G" at the end but The Missing Link is connected to "My Network" (without "5G" at the end), they may not be able to see each other correctly.

2.4 GHz vs 5 GHz WiFi

The Missing Link can only communicate on a 2.4 GHz WiFi antenna. If your WiFi router has combined both the 5 GHz and 2.4 GHz networks under one name (this is quite common) it is possible your computer or other devices are connected to the 5 GHz network and your Missing Link will be connected to the 2.4 GHz network. These two combined networks may not be able to send Link between them. It is best to name your 2.4 GHz network differently from your 5 GHz network. This way you can be assured that all the devices you wish to Link together are on the 2.4 GHz network.

Be sure there's a trailing slash in the URL: **<http://ml2-xxxx.local/>**

If that doesn't work try dropping the .local from the URL: **<http://ml2-xxxx/>**

When you are connected to your ML:2^m via its Access Point Mode you can use this IP address to access the Editor: **<http://192.168.4.1>**

When your Missing Link is connected to your own WiFi network, then the IP address is usually dynamically assigned by your WiFi router. You should be able to find the IP address of your Missing Link via the administration panel of your WiFi router. You should be able to set up your router to assign your ML:2^m a fixed IP address. You can then bookmark this IP address in your web browser.

More detailed WiFi and Link troubleshooting can be found in my [Link Troubleshooting knowledgebase article](#).

10 Factory Reset

In the off-hand case that your ML:2^m gets confused or lost from your network with nary a breadcrumb to find your way back to it, you can apply a factory reset to revert your ML:2^m back to the state it was in when you first took it out of its pink and orange box for the first time.

To perform a factory reset:

1. Power off your Eurorack system's power.
1. Press and hold the Play and Tap buttons on ML:2^m.
2. While continuing to hold those two buttons down, power on your system.
3. Keep holding the Play and Tap buttons until ML:2^m "+" button blinks continuously. Now you can release the Play and Tap buttons. *Note: if you decide at this moment that you do not wish to continue with the factory reset, stop and do nothing. Wait a few seconds and the reset will time out and boot up normally. If you do wish to reset ML:2, continue on to step 5 before that timeout period ends.*
4. Press the + button three times to initiate the factory reset.
5. ML:2^m buttons will show the progress of the reset. When it is complete the device will reboot.
6. ML:2^m should now be in Access Point Mode. The name of the Access Point will be the same as the serial number sticker on ML:2^m circuit board or the quick start card included in your box.

If you run in to any issues, don't hesitate to [Contact Us!](#)

11 Credits

First of all, I want to thank my incredible wife, Christina, for supporting me throughout this whole Circuit Happy adventure! Circuit Happy would not exist without her.

Thank you to:

- [Matthew Campbell](#) for his investment of time and effort for a multitude of things:
 - ML:2^m redesigned PCBs with a far more robust board to board connection and EEPROM manufacturing data storage.
 - New hardware program and test fixture
 - In-house PCB assembly with a Lumen pick n place and a SMT oven.
 - General guidance on firmware development.
- Nick Donaldson, aka [Infrasonic Audio](#), for starting this project with me seven years ago, and then more recently rebuilding the Junior firmware which ML:2^m was then based upon.
- [Matthew Hodson aka MATTHS](#) for his efforts in helping spread the word about Circuit Happy and also his insights in to new product features including Rhythm Mode.
- Neil Kolban's incredible gift of ESP32 knowledge [deposited on GitHub](#) and throughout the Espressif forums. Much of ESP32-snippets were referenced to find my way during the development of Junior and ML:2.
- [Marcos Carvalho](#) for drawing the Missing Link fishy.



Where's that fishy going?